

REMARKS

Claims 1-4, 10-19, 22, 23, 28, 29, 34, and 36-41 are present in the case upon entry of this Amendment. Claims 1, 23, 28, 29, 34, and 36 have been amended. Claims 37-41 have been added, and no claims have been cancelled herein. Claims 5-9, 20, 21, 24-27, 30-33, and 35 were previously cancelled without prejudice in a Preliminary Amendment.

Claims 1, 28, 29, 34, and 36 have been amended herein to recite the formulations or compositions as being non-fluxing underfill formulations or compositions, as the case may be. Support for these amendments to claims 1, 28, 29, 34, and 36 is found at paragraph [0012] on page 4 of the specification.

Support for added claims 36-41 is found at paragraph [0014] on page 4 of the specification.

Information Disclosure Statement:

An Information Disclosure Statement is being filed concurrently with the present Amendment, and is deemed to meet the requirements of the Office relative to the filing of Information Disclosure Statements. As such, the deficiencies recited on page 2 of the Office Action are deemed to have been fully met and overcome.

Claim Objections:

Claim 23 has been amended herein to change its dependency from claim 3 to claim 4, in accordance with the suggestion as provided on page 11 of the Office Action. In light of the amendments herein and the preceding remarks, reconsideration and withdrawal of the objection to claim 23 is respectfully requested.

Rejections under 35 U.S.C. §103(a):

I. United States Patent No. 6,180,696 B1 (Wong et al.)

Claims 1-3, 10, 11, 22, 28, 29, 34, and 36 stand rejected under 35 U.S.C. §103(a) as being unpatentable over United States Patent No. 6,180,696 B1 (Wong et al.). This rejection is respectfully traversed in light of the amendments herein and the following remarks.

Independent claims 1, 28, 29, 34, and 36 all define the underfill material as a non-fluxing underfill formulation or composition. The non-fluxing formulations and compositions of Applicants' present invention are substantially free of fluxing agents. Wong et al., however, specifically teach fluxing no-flow underfill materials. In particular, Wong et al. disclose no-flow underfill materials that include: an epoxy resin; an organic carboxylic acid anhydride hardener; a curing accelerator; a fluxing agent; a coupling agent; and a surfactant. Clearly the no-flow underfill materials of Wong et al. include a fluxing agent. Accordingly, the compositions are entirely different from the non-fluxing underfill compositions of the present claims.

The present specification provides clarification as to the differences between a non-fluxing underfill composition when compared with a fluxing underfill composition. As defined in paragraph [0012] of the present specification, non-fluxing formulations and compositions, such as in those claimed, have a reduced cure onset temperature that is less than soldering temperatures at which, for example, solder bumps melt (or reflow) during chip mounting procedures, whereas fluxing formulations and compositions have a cure onset temperature that is equal to or greater than soldering temperatures at which, for example, solder bumps melt (or reflow) during chip mounting procedures. In this manner, fluxing compositions are typically capable of curing below solder reflow temperatures, while fluxing formulations are typically cured above solder reflow.

Such differences in curing profiles are particularly important in terms of use of the compositions. Non-fluxing compositions, such as those claimed in the present application, may be used as underfill encapsulants typically through a capillary flow procedure, in which encapsulation occurs separately from a solder reflow procedure where the solder bumps are electrically connected between a chip and a substrate. Accordingly, the curing temperature for such non-fluxing compositions is below the solder reflow temperature so as to prevent the solder from reflowing during curing of the underfill composition. On the other hand, no-flow fluxing underfill materials, such as the no-flow fluxing underfill materials of Wong et al., are intended to be fully cured during the solder reflow process. Accordingly, they have a curing temperature that is above solder reflow, and necessarily include a fluxing agent, since the solder reflow

occurs during the curing and fluxing is necessary for proper reflow of the solder for electrical connection.

Accordingly, the non-fluxing underfill compositions of the present claimed invention are distinct from the fluxing no-flow compositions of Wong et al. Such a distinction is even more apparent from the specifications of both the present application and Wong et al. Applicants' present specification distinguishes from the presence of fluxing agents in their non-fluxing formulations, because fluxing agents are capable of reacting with the underfill formulation, resulting in degraded properties, such as poor flow properties. See, for example, paragraph [0017] at page 5 of the specification. Such flow properties are particularly important for non-fluxing underfill compositions, since they are typically used in a capillary flow procedure. And Wong et al. specifically teach away from non-fluxing underfill compositions as claimed in the present invention, such as at column 2, lines 28-36, where it is noted that the no-flow encapsulant of Wong et al. has a self-fluxing ability as a primary requirement, due to the inclusion of a fluxing agent, and also at column 2, lines 3-27, where flowable underfill compositions such as those of the present invention are specifically distinguished from the no-flow compositions of Wong et al., based on the curing profiles and solder reflowing, which solder reflowing relates to fluxing ability.

In fact, newly added claims 37-41, specifically define the composition as a capillary flow underfill composition. Wong et al. provide no disclosure, teaching, or suggestion with regard to capillary flow underfill formulations and compositions. In fact, as noted, Wong et al. teach away from capillary flow underfill formulations and compositions. See column 2, lines 3-14 of Wong et al. Capillary underfill formulations and compositions have a reduced viscosity that allows them to be drawn by capillary action into the space between a chip and an underlying substrate, such as a circuit board, after the chip has been mounted onto the underlying substrate. See, for example, paragraph [0009] on page 3 of the specification. No-flow underfill materials, by contrast, have an elevated viscosity that renders them incapable of being drawn by capillary action into the space between a chip and an underlying substrate, such as a circuit board after the chip has been mounted onto the underlying substrate, as would be recognized by a skilled artisan. No-flow underfill materials are applied to a substrate (e.g., a circuit board) before the

chip is mounted onto the underlying substrate, as would be recognized by a skilled artisan. See, for example, column 5, lines 48-67 of Wong et al.

The disclosure and teachings of Wong et al. are limited to fluxing no-flow underfill materials. As discussed above and in summary, fluxing no-flow underfill materials include fluxing agents; undergo minimal cure at temperatures below solder bump reflow temperatures; and undergo rapid curing at or above solder bump reflow temperatures. Non-fluxing underfill formulations, however, are free of fluxing agents; undergo substantially complete cure below solder bump reflow temperatures; and as such, undergo minimal subsequent curing at or above solder bump reflow temperatures. Wong et al. provide no disclosure, teaching, or suggestion with regard to non-fluxing underfill formulations or compositions, and in fact specifically differentiates and teaches away from flowable compositions. As such, the disclosure of Wong et al. does not teach or otherwise touch upon the non-fluxing formulations of the methods of Applicants' present claims.

In light of the amendments herein and the preceding remarks, Applicants' claims are deemed to be unobvious and patentable over Wong et al. Reconsideration and withdrawal of the present rejection is respectfully requested.

II. United States Patent Application Publication No. 2004/0087681 A1 (Shah)

Claims 1-4, 10, 11, 22, 23, 28, 29, 34, and 36 stand rejected under 35 U.S.C. §103(a) as being unpatentable over United States Patent Application Publication No. 2004/0087681 A1 (Shah). This rejection is respectfully traversed in light of the amendments herein and the following remarks.

Shah discloses no-flow underfill compositions that include: an epoxy resin; a fluxing agent; a linear polyanhydride; a core shell polymer toughener; and a catalyst. See the Abstract; and paragraphs [0008], [0010], and [0015] of Shah.

As with Wong et al., the no-flow underfill materials of Shah are fluxing no-flow underfill materials, as would be recognized by a skilled artisan. The no-flow underfill materials of Shah include a fluxing agent. In addition, the no-flow underfill materials of Shah are

described as fluxing and curing during solder reflow in a reflow oven (*i.e.*, at soldering temperatures). See, for example, paragraph [0007] of Shah.

The disclosure and teachings of Shah are limited to fluxing non-flow underfill materials. Shah provides no disclosure, teaching or suggestion with regard to non-fluxing underfill formulations or compositions. As such, the disclosure of Shah does not reach or otherwise touch upon the non-fluxing formulations of the methods of Applicants' present claims.

Regarding added Claims 37-41, the disclosure and teachings of Shah are limited to no-flow underfill materials. Shah provides no disclosure, teaching or suggestion with regard to capillary flow underfill formulations and compositions.

In light of the amendments herein and the preceding remarks, Applicants' claims are deemed to be unobvious and patentable over Shah. Reconsideration and withdrawal of the present rejection is respectfully requested.

III. Wong et al. or Shah in view of United States Patent Application Publication No. 2004/0101688 A1 (Rubinsztajn et al.)

Claims 12-19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wong et al. or Shah in view of United States Patent Application Publication No. 2004/0101688 A1 (Rubinsztajn et al.). This rejection is respectfully traversed in light of the amendments herein and the following remarks.

Rubinsztajn et al. disclose curable epoxy formulations that include: epoxy monomer; organofunctionalized colloidal silica; and a cure catalyst. See the Abstract, and paragraphs [0004] and [0032] of Rubinsztajn et al.

As discussed previously herein, Wong et al. disclose no-flow underfill materials that include: an epoxy resin; an organic carboxylic acid anhydride hardener; a curing accelerator; a fluxing agent; a coupling agent; and a surfactant. The disclosure and teachings of Wong et al. are limited to fluxing non-flow underfill materials. Wong et al. provide no disclosure, teaching, or suggestion with regard to non-fluxing underfill formulations or compositions. Similarly, Shah discloses no-flow underfill compositions including a fluxing agent, as discussed previously herein. The disclosure and teachings of Shah are limited to fluxing non-flow underfill materials.

Shah provide no disclosure, teaching, or suggestion with regard to non-fluxing underfill formulations or compositions.

Rubinsztajn et al. in combination with Wong et al. or Shah would necessarily result in a fluxing no-flow underfill composition, particularly since Wong et al. and Shah are limited to such compositions. As such, Wong et al. and Shah, whether considered alone or in combination with Rubinsztajn et al., provide no disclosure, teaching or suggestion with regard to non-fluxing underfill formulations and compositions.

Regarding added claims 37-41, Rubinsztajn et al. in combination with Wong et al. or Shah would necessarily result also in a no-flow underfill composition. As such, Wong et al., Shah and Rubinsztajn et al., alone or in any combination, provide no disclosure, teaching or suggestion with regard to capillary flow underfill formulations and compositions.

In light of the amendments herein and the preceding remarks, Applicants' claims are deemed to be unobvious and patentable over Wong et al. or Shah in view of Rubinsztajn et al. Reconsideration and withdrawal of the present rejection is respectfully requested.

IV. Wong et al. in view of Shah

Claims 4 and 23 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wong et al. in view of Shah. This rejection is respectfully traversed with regard to the amendments herein and the following remarks.

A combination of Wong et al. and Shah would necessarily result in a fluxing no-flow underfill composition, since both Wong et al. and Shah are limited to fluxing no-flow compositions. As such, Wong et al. and Shah, alone or in combination, provide no disclosure, teaching, or suggestion with regard to non-fluxing flow underfill formulations and compositions. Moreover, regarding added claims 37-41, and as discussed previously herein, the disclosure and teachings of Wong et al. and Shah are limited to no-flow underfill materials, with Wong et al. specifically teaching away from capillary flow underfill formulations and compositions. See column 2, lines 3-14 of Wong et al. Accordingly, a combination of Wong et al. and Shah would necessarily result in a no-flow underfill composition, and alone or in combination, would provide

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no disclosure, teaching, or suggestion with regard to capillary flow underfill formulations and compositions.

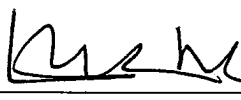
In light of the amendments herein and the preceding remarks, Applicants' claims are deemed to be unobvious and patentable over Wong et al. in view of Shah. Reconsideration and withdrawal of the present rejection is respectfully requested.

CONCLUSION

In light of the amendments herein and the preceding remarks, Applicants' presently pending claims are deemed to define an invention that is unanticipated, unobvious and hence, patentable. Reconsideration of the rejections and allowance of all of the presently pending claims is respectfully requested.

Should the Examiner have any questions regarding this response or wish to discuss this matter in further detail, the Examiner is invited to contact Applicants' undersigned representative by telephone at 412-471-8815.

Respectfully submitted,
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